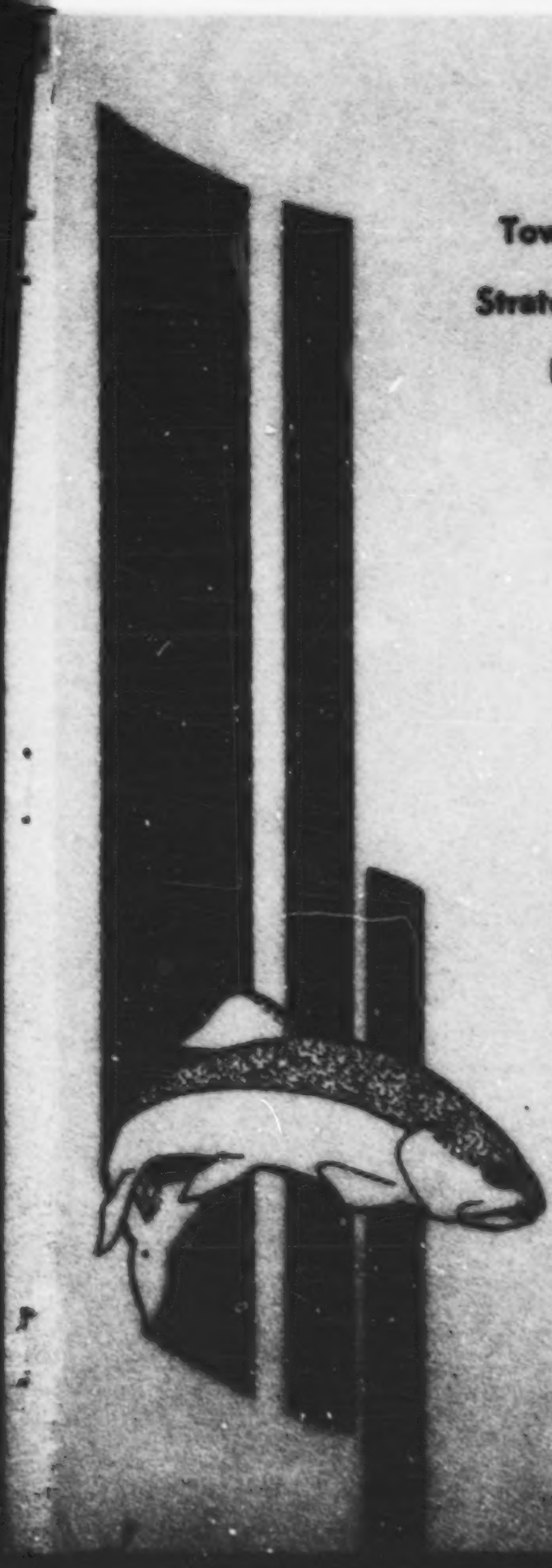

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TOWARDS AN EFFECTIVE MANAGEMENT STRATEGY FOR RESIDENT SALMONID STREAM FISHERIES IN BRITISH COLUMBIA

by

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ABSTRACT

Slaney, P.A., A.D. Martin, G.D. Taylor, M.L. Rosenau, G.E. Reid, D.H.G. Ableson (Rivers Management Committee). Towards an effective management strategy for resident salmonid stream fisheries in British Columbia. 1984. Fisheries Technical Circular No. 66. 20 p.

Stream fisheries for resident trout and char are in high demand and initial surveys of the status of a sample of accessible streams in southern British Columbia indicated most populations are depressed, depleted or contain few large fish. Three options for more intensively and effectively managing these fisheries are rotating closures, stocking of catchables in accessible reaches, and special regulations. Emphasis on special regulations was considered most compatible with Provincial fisheries policy. A management strategy is recommended that establishes four management classes for stream fisheries: Wild A (accessible), Wild B (inaccessible), Trophy and Hatchery Supported. Several constraints on management practices and regulations are incorporated into each class. Restrictive or "special" regulations are necessary for Wild A and Trophy stream fisheries to ensure targets of acceptable standing crop, catch success and fish size. Accumulating evidence from elsewhere suggests that special regulations are effective if adequately designed and enforced, but high natural mortality may reduce or eliminate their effectiveness in some streams.

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INTRODUCTION

Stream fisheries in British Columbia comprised 40% of the angler effort expended in freshwater during 1978-79 (Warner 1980 M.S.). Approximately 20% was directed at sea-run trout and salmon, and 20% at resident salmonids (B. Ford, pers. comm., re-analysis of Warner 1980 M.S.). Roderick Haig-Brown (1965) observed that "stream fishing is in the highest possible demand, especially among the more knowledgeable anglers, and no amount of lake fishing, even of superior quality, can compensate for it". Studies conducted elsewhere support this perspective (Gordon, Chapman and Bjornn 1969). Mallet (1980) found in Idaho, where angling is about evenly distributed between lakes and streams, that 66% of anglers preferred rainbow trout fishing on streams compared to 34% on lakes. Where demand is not satisfied, it is probable that stream anglers travel elsewhere rather than shifting to lake angling (A. Martin pers. comm. 1982). Fisheries managers should ensure these preferences are accounted for in management plans, and stream fisheries are producing at sustainable levels reflecting their biological capability.

The policy goal of the Provincial Fisheries Program is to "produce the maximum economic, cultural, recreational and scientific benefits for present and future generations of British Columbians by a) maintaining all native or desirable introduced species at optimal levels of distribution, abundance and health, and protecting essential freshwater habitat, and b) providing an equitable distribution of opportunities for a wide variety of uses of fish". In 1985 this goal was modified: "to provide social and economic benefits to society through the conservation and management of freshwater fisheries and marine resources and associated habitats." The purpose of this report was for the Rivers Management Committee to examine whether present stream fisheries for resident salmonids, particularly trout and char, adequately reflect fisheries policy objectives. Also, management options are reviewed and a compatible fisheries management strategy is recommended for these fisheries.

STATUS OF STREAM FISHERIES

There are greater than 300 mainstem streams (>17,000 km) in British Columbia supporting fisheries for resident salmonids. This does not include the numerous tributaries and smaller streams that also are inhabited by fishable salmonids. In terms of total stream length, 2% are located on Vancouver Island, 3% in the southern mainland, 6% in the Okanagan, 8% in the Thompson, 9% in the Cariboo, 9% in the Skeena, 16% in the Kootenays and 47% in Omineca-Peace areas (Table 1). About 25% of these streams probably receive some contributions from lake stocks of migratory trout and char (Slaney and Rosenau 1982 M.S.).

Table 1. Numbers and total lengths[1] of streams by management areas supporting stream fisheries for resident salmonids. (Small streams and tributaries of mainstems are excluded.)

	MANAGEMENT AREA								
	Vancouver Island	Southern Mainland	Thompson - Nicola	Kootenays	Cariboo	Skeena	Omineca-Peace	Okanagan	Total
Number of Streams	25	20	28	68 (+ 5)[2]	29	38	77	20	305
Total Length (km)	371	419	1,354	2,703	1,552	1,587	8,094	1,025	17,105
Mean Length (km)	15	21	48	39	54	42	104	51	56

[1]Lengths are minimums because these were measured from large scale maps (mainly 1:50,000)

[2]Whitefish only

No comprehensive survey is available that examines the status of these fisheries or their populations of salmonids. However, there are several streams where fish populations have been recently censused, or where angler's catches have been sampled. Late summer or fall standing crops were compared to the equivalent of a moderately fished standing crop calculated from a capability model (Habitat Quality Index or HQI, Binns 1982). The pattern for most streams was generally typical of over-exploited populations of trout and char, small fish dominating the stream or creel, followed by a depleted population comprised of a few trout or char of small to moderate size (Nehring 1983). Seven accessible and larger streams in British Columbia, managed with a quota of 8-16 (catch-possession), ranged from seriously depressed to depleted of trout and char, or < 10% of capacity (Table 2). A 30 cm size limit on the highly accessible lower Clearwater River did not improve stock status, probably because of liberal quotas and excessive post-hooking mortality from bait (e.g. Stringer 1967, Wydoski 1977). Whitefish, in contrast, were abundant in most of these streams. For example, whitefish accounted for 80% of the catch in the fishery at the Elk River in the East Kootenays (Martin 1983). Two smaller streams, Hat Creek and Beaver Creek were exceptions (Table 3). At the latter, dense streamside vegetation restricts access to anglers (R. Ptolemy pers. comm.); and at Hat Creek, no large trout were evident, although sampling distance was comparatively small. Stock status at the Bonaparte River suggests the effect of angler accessibility; the most accessible reach was 14% of capacity, compared to 80% in a more isolated section (Table 3). The upper Nechako River (quota 5 daily, 10 possession) was 20 to 25% of capacity despite access that required considerable driving distance from population centers (Table 2). Factors other than fishing may be limiting some of these populations (e.g. agriculture impacts at the lower Similkameen, storage releases and few tributary rearing areas at the Nechako). However, stream dwelling trout are highly vulnerable to over-exploitation; for example, at a small Idaho stream (length 4 km, width 3 m) 50% of all catchable-size cutthroat trout were harvested with only 32 hr of angling effort (McPhee 1966). Similarly, 22% of cutthroat trout > 20 cm were captured by fly fishing at an effort level of 7 hr/ha at the St. Mary River in British Columbia (Slaney and Martin 1985 M.S.).

A more complex fishery is active on the Skagit River system where both residual lake migrants and resident stream trout and char are harvested in a "mixed stock fishery". Again, stock status was highly depressed in the more accessible reaches (Table 3), regardless of a shift to reduced quotas (4/day, 8 possession, 20 cm minimum). It is suspected the HQI overpredicts capability of this river because the "above barrier" reach is only lightly fished.

A comprehensive survey of catch and effort was conducted on the Elk River in the Kootenay Region (Martin 1983; quota 4-4

Table 2. Estimated abundance[1] of mountain whitefish, trout and char in some accessible[2] interior rivers during July and September 1983, and a comparison of estimated trout/char standing crop (kg/ha) with HQI standing crop capability[3] (present trout/char fishery regulations; 8 catch, 16 possession except Nechako River, 5-10; no size limits except Clearwater River, 30 cm).

River	Location	Distance km	Count Expand. Factor	Adult Whitefish No./km	Trout Char No./km (≥ 1+)	Trout Char No./km (≥ 30 cm)	Trout Char kg/ha	HQI (kg/ha) Capacity	Per Cent of Capacity	Comments
Tulameen	Coalmont d/s	1.9	2.8X	180	12	0	0.51	2.4-12[4]	4-21%	
Mid-Similkameen	Hedley u/s	3.5	4.2	290	16	0	0.71	7-21[4]	4-10	
Low-Similkameen	d/s Keremeos	6.0	4.8	2850	22	4	0.75	6-16[4]	5-13	
Up. E. Kettle	Christian Valley d/s	1.8	4.2	100	2	0	0.10	20.8	1	
Mid-Kettle	Rock Creek	2.3	4.8	140	6	4	0.37	18.6	2	
West Kettle	Westbridge, 5 km u/s	1.5	2.8	0	2	0	0.37	49.1	1	
Low-Clearwater	Clearwater	3.3	8.4	1550	110	5	1.5	47.2	3	No bait ban eliminates effectiveness of 30 cm size limit.
Upper Nechako	d/s Cheslatta (Reach 1)	5.8	4.2	-	60	10 (est.)	3.5	14-17	20-25	Closed to angling in 84/85

[1]Upper Nechako River surveyed by M.R. Rosenau, D.G. Ableson and P.A. Slaney on July 8, 1983; other surveys conducted by B.R. Ward, C.P. Perrin and P.A. Slaney on September 12 to 16, 1983 (two shore counters, one mid-river counter). All counts expanded by estimated % of river not observed plus data from Northcote and Wilkie 1963 (40% trout and whitefish undetected by swimmers). Counts were therefore expanded by 2.8 (Tulameen) to 8.4 (Clearwater) and therefore are considered overestimates of abundance. Trout/char were visually separated into 10 cm length classes during census.

[2]All sites were classed as accessible; within 2 km of a road; least accessible was the Upper Nechako and 50% of the Lower Similkameen sections.

[3]HQI capability; standing crop in kg/ha derived from the Wyoming Habitat Quality Index model (II) which assumes trout/char are fished at a level less than maximum sustained yield (ref. Binns. N.A. 1982). Habitat Quality Procedures Manual, Wyoming Dept. Game and Fish: 209 pp).

[4]HQI capacities: min. estimates from Hickey *et al.* 1984, $NO_3N < 0.01$ mg/ℓ; max. estimates based on $NO_3 \geq 0.01$ mg/ℓ.

Table 3. Estimated abundance of mountain whitefish, trout and char in additional streams in British Columbia during 1980 to 1983, and a comparison of estimated trout/char standing crop (kg/ha) with model predictions of standing crop capability.

River	Location	Distance km	Count Expand. Factor	Adult Whitefish No./km	Trout Char No./km (≥ 1+)	Trout Char No./km (≥ 30 cm)	Trout Char kg/ha	HQI (kg/ha) Capacity	HCM (kg/ha) Capacity	Per Cent of Capacity	Comments
Skagit R. (R1)[1]	to 26 mi	12.1	3.3	0	107	16	4.6	73	(41)	6 (11)	lake stock dominant
Skagit R. (R2)[1]	to Sumallo	9.5	5.4	0	70	11	4.5	162	(66)	3 (7)	lake stock dominant
Skagit R. (R3)[1]	to barrier	2.2	5.0	0	386	18	19.5	151	(93)	13 (21)	lake stock dominant
Skagit R. (R4)[1]	u/s barrier	1.7	2.9	0	527	7	40.7	151	(63)	27 (65)	light fishing pressure
Klesilkwa R.[1]		4.1	3.3	0	72	17	7.8	144	(-)	5 (-)	lake stock dominant
Sumallo R.	lower	7.8	6.7	0	52	5	3.7	227	(125)	2 (3)	some lake migrants probable
Beaver Cr.[2]	Marsh Cr. Road	3.0	1.0	-	2000	400	130	110		100+	some access limitation by streamside vegetation
Bonaparte R.[3]	Cache Cr. to Loon Cr.	0.14	-	-	60	0	6.5	45		14	
Bonaparte R.[3]	Loon Cr. to Clinton Cr.	0.02	-	-	540	0	44.6	52		86	limited access; 3 km trail
Bonaparte R.[3]	Clinton Cr. to Rayfield Cr.	0.07	-	-	340	0	17.7	52		34	
Hat Cr.[3]	lower	0.07	-	-	350	0	40.1	50[4]		80	

[1]Data supplied by R. Griffith; HQI calculations from Binns 1982; HCM calculations from Rosenau et al. 1983; harvest quota 4 (8) in 1982/83.

[2]Data supplied by R. Ptolemy; HQI calculations from Binns 1982; quota 8 (16)

[3]Data obtained from Tredger (1980), HQI calculations from Binns 1982; populations estimated from electrofishing census (1-step Delury); quota 8 (16)

[4]HQI calculation is minimum owing to indefinite NO3N concentration (assumed to be 0.02 mg/ℓ); quota 8 (16)

in 1982/83). Twenty-nine thousand (23,200 angler trips) and 30,400 (20,900 angler trips) angler hours were expended on cutthroat trout plus Dolly Varden char (mainly summer), and whitefish (mainly winter) respectively. Corresponding harvests were 15,800 (158/km) and 64,100 (641/km). Although numerically the status of the fishery on this stream appears adequate, catch success was only 0.5/hr and trout and char entering the creel were small and young. About 25% of trout were > 26 cm and 10% > 30 cm, and about 50% $\leq$ age 2+ (trout) and $\leq$ age 3+ (char). In contrast, trout and char were larger and older in a large tributary, the Wigwam River, closed temporarily to angling (Martin 1983). Compared to cutthroat populations in two nearby streams in Alberta, trout from the Elk River were mainly harvested prior to first spawning at age 3 and 4 (Radford 1975 M.S., Martin 1983). In this fishery, with its increasing angling pressure, gradual depletion of these populations is predicted without a shift to more restrictive regulations (Martin 1983).

Studies of two Kootenay streams that were temporarily closed to angling demonstrate the size of fish that can be produced in these streams if the fishery was more restrictively regulated. The Wigwam River was closed for 2.7 years, and subsequent sampling indicated the size distribution of cutthroat trout was 70% > 30 cm and 12% > 40 cm (Martin 1983). Natural mortality was not of major significance until trout were > 35 cm or age 4+. Similarly, at the less productive Upper St. Mary River, mean size and age in the creel increased from 23 to 29 cm and age 2+ to 3+, respectively (Martin and Bell 1984). Restrictive or special regulations, if designed correctly, should maintain this type of "quality" in the fishery (Baughman 1983).

In summary, accumulating evidence indicates that stocks of resident trout and char in our streams that are relatively accessible to anglers are depressed to depleted, whereas whitefish are relatively abundant. Liberal quotas and limits have been largely ineffective in maintaining populations and are, therefore, inconsistent with provincial policy.

MANAGEMENT OPTIONS FOR STREAM FISHERIES

Demand in excess of supply is characteristic of trout fisheries on accessible streams throughout western North America. Several agencies in the United States have dealt with this problem by initiating large hatchery programs with emphasis on stocking "catchables". In the past decade, however, this trend has been reversed owing to several factors including evaluations of the impact of "catchables" on wild trout (50% loss of the latter; Vincent 1974), the high cost of "catchables" stocking, and far from least, the lobbying of knowledgeable client groups for a return to wild trout management. Three different approaches are presently utilized in an attempt to resolve the problem of demand exceeding supply and these are typified by Alberta, California and Wyoming.

1. Rotating Closures

Alberta managed stream fisheries in the 1940's to 1950's by a) fingerling or yearling stocking of overharvested streams, b) a restrictive size limit (20 cm), c) closure during the spawning period, and d) closure of minor tributaries to maximize juvenile production to the mainstem. As a result of Miller's conclusions (1952) these "policies" were abandoned for several reasons including Miller's evidence that survival of stocked juveniles was reduced to low levels because of competition with wild trout. Management was subsequently simplified to permit annual open seasons on large rivers and alternate year openings of tributary streams, with a quota of 10 cutthroat trout and a delayed opening in the spring. Evaluations by Radford (1975) suggest the present strategy is effective on the tributary rivers. Trout and char are more abundant and larger than they would be without the alternate year closure (Martin and Bell 1984).

The primary advantage of rotating or alternating closures is simplicity of regulations, but there are several disadvantages including reduced angling opportunity. Many streams are closed in any year, thus promoting crowding on open streams. Albertans have travelled elsewhere to engage in stream fishing (Martin 1983). Excessive crowding is also prevalent in the period directly after opening of the stream to angling (Martin and Bell 1984). Furthermore, fishing for other species is eliminated, including whitefish, which are not over-exploited. This approach conflicts with the existing fisheries policy in British Columbia because it affords little diversity, prevents use of some streams each year, thus translocating effort elsewhere, and encourages excessive crowding during initial opening days.

2. "Catchables" Emphasis

California is typical of this approach which maintains the option of "catch and keep" where demand is high. It is based on the premise that it is impossible to maintain "roadside fisheries" without stocking, and stocking "catchables" is considered more economic than juveniles or subcatchables (i.e. 70% of the former are creeled; Butler and Borgeson 1965, Forshage 1975). The "catchables" emphasis on highly accessible streams is coupled with some restrictive regulations on streams with moderate fishing pressure, and liberal regulations on low pressure or inaccessible streams. These regulations apparently are effective and considered economic in a state with a large population of anglers. The opposition to stocking juveniles versus "catchables" is based on several early evaluations summarized in Burns and Calhoun (1966) and similar to Miller's studies in Alberta. Owing to a "catchables" emphasis, this approach conflicts with the general fisheries management policy

in British Columbia, which establishes the goal of optimum utilization of natural habitat by native or introduced species.

3. Management Concepts Approach

In the past decade, management of wild trout fisheries has re-emerged as an important goal, particularly in the mid-western United States. Stocking of "catchables" has become de-emphasized owing to cost of production, and also client dissatisfaction (Wyoming Game and Fish Dept.; R. Wiley pers. comm. 1982). The concept or classification approach identifies several management objectives and streams are then designated to be managed for specific objectives. This mixed management strategy has evolved in several states including Wyoming, Wisconsin, Idaho and Colorado. Wyoming has developed the strategy into a system of five Management Concepts in which one or more concepts are applied to each lake or stream (Baughman 1983):

a. Sustained Yield Concept: general fishing, stocking of juveniles, maximize fish to the creel

b. Trophy Concept: restrictively regulated to obtain trophy size fish in the creel or catch

c. Wild Concept: no stocking, natural reproduction, restrictive regulations where there is any significant effort

d. Species Concept: restrictively regulated, if necessary, for ensuring adequate and continued production of special species or subspecies

e. Put-and-Take Concept: "catchables" program; receiving recent de-emphasis

Advantages of these concepts are that they permit a wide diversity of angling opportunities and management objectives which are not always compatible; i.e. some fisheries can each be managed mainly for the consumptive fisherman, the recreationist, and the ardent or dedicated fisherman. The concepts also recognize that fish exploitation will, in some cases, have to be controlled by special regulations in order to maintain targets of 1) acceptable fish size, 2) catch rates (1/angler hr is a common target), and 3) standing crops (Baughman 1983).

However, application of more than one concept to a section of stream has caused some controversy in Wyoming (R. Wiley pers. comm. 1982). Also, this type of management requires both additional enforcement and publication education to ensure that special regulations remain effective (Lewynsky 1982 M.S.).

Thus, for Wild and Trophy Concepts, special regulations are automatic where any significant effort is anticipated, and several "constraints" are adhered to, including 1) use of regulations as a management tool and not to obtain special waters (e.g. fly fishing), 2) proceed only after careful analysis (e.g. need to know stock characteristics to set limits, particularly size (growth, age and size at spawning), 3) minimize discrimination or removal of opportunities, 4) select limited kill over no-kill fisheries, 5) institute terminal tackle restrictions necessary to reduce mortality; artificial lure (treble hooks) plus artificial fly is favoured over artificial fly only (4% post-hooking mortality for flies, 6% for lures, 25% for bait; Wydoski 1977), 6) evaluate the effectiveness and modify as necessary (Baughman 1983).

Stocking of juveniles under the Sustained Yield Concept (mainly age 1+ yearlings < 13 cm (20-25 g) stocked in the autumn as "subcatchables") has become more acceptable because survival rates have improved over the earlier evaluations (Miller 1952; Burns and Calhoun 1966), probably owing to improved practices of fish culture and careful selection of stocking sites (e.g. few wild fish, more dispersed stocking). In Wyoming return to the creel from large fingerlings and yearlings is approximately 6% and 15%, respectively, compared to earlier results elsewhere of 2.4% and 8% (R. Wiley pers. comm. 1983).

In summary, the management concepts approach is most compatible with the provincial fisheries policy (in effect in 1984) that emphasizes optimum utilization of habitat capacity and diversity of opportunities. Adoption of management concepts or classes is recommended by the Rivers Management Committee as a practical means for establishing some structure and order in managing resident salmonid stream fisheries.

AN EFFECTIVE MANAGEMENT STRATEGY FOR STREAM FISHERIES

MANAGEMENT CONCEPTS OR CLASSES

Effective management of accessible stream fisheries for resident salmonids requires a shift to more intensive management including use of management concepts or classes which rely largely on special regulations. Management classes are not new to the Fisheries Program, where they are used for about 400 steelhead streams in order to minimize genetic and ecological risk; i.e. "wild", "augmented" and "hatchery" designations with various constraints. These should become incorporated into an overall set of concepts for stream fisheries, of which four are recommended by the Rivers Management Committee:

1. Wild Class A (accessible) (i.e. high effort)
2. Wild class B (inaccessible) (i.e. low effort)
3. Trophy
4. Hatchery supported

Streams or, in some cases, reaches of streams would be classified to be managed under the constraints of a concept or class. To avoid confusion and controversy, two concepts could not be applied to the same reach.

1. Wild Class A (accessible):

   (a) More emphasis on non-consumptive than consumptive angling.

   (b) Managed primarily with special regulations including a low quota, size limit and summer bait ban (Appendix 1); the primary option is limited kill (i.e. max. daily quota 1 to 3 depending on productivity and effort levels) to maintain targets for acceptable standing crop, fish size and catch rate. Catch and release is a secondary option if limited kill is predicted to provide insufficient spawners, or to accelerate restoration.

   (c) Where effort is high enough to cause high total mortality (creeled fish and hooking mortality of released fish; e.g. > 30%) a limited kill fishery would require shifting to catch and release only regulations. The alternative is to manage the stream or reach within the Hatchery Supported concept if the stream is highly accessible.

   (d) Reliance on habitat protection and improvement for restoration and enhancement, respectively.

   (e) Natural recruitment only; no stocking except temporarily for restoration of depleted stocks or species introduction.

   (f) Under constraint (e), maintenance of genetic integrity by restorative stocking with native fish or similar stock; stream stock only.

   (g) Introduction of another species to be compatible with existing species.

   (h) Mixed stock fisheries: less restrictive regulations where lake stock dominates over resident stock in the fisheries; otherwise manage to the resident stock to improve overall quality. The exception to this is where the stream produces juveniles mainly for a lake fishery which is the primary management focus.

2. Wild Class B (inaccessible) Constraints:

   (a) No emphasis with respect to nonconsumptive angling.

   (b) Managed by general regulations with more liberal quotas than Wild Class A; few, if any, restrictions except seasonal closures.

   (c) Reduction of daily quotas by geographic areas for this class, daily quotas for aggregate trout and char of 2 (coastal regions), 3 (northern regions) and 4 (S. interior regions), thus coinciding with stream productivity.

   (d) Exceptions of higher quotas may be necessary if "stunting" is evident in low effort fisheries, where juvenile recruitment is high.

   (e) Restoration by habitat protection.

   (f) Natural recruitment, no stocking unless to introduce species; stream stock only.

   (g) Introduction of another species to be compatible with existing species.

3. Trophy Class: Constraints

   (a) Major emphasis on non-consumptive fisheries

   (b) Reliance on limited kill or catch and release regulations to maximize abundance of large older fish. A "slot limit" may be necessary to prevent "stunting" in some productive streams with high natural recruitment (see p. 13).

   (c) Reliance on habitat protection and improvement for restoration and enhancement, respectively.

   (d) Natural recruitment only except in special circumstances (e.g. introduction of new species).

   (e) Introduction of another species to be compatible with existing species.

4. Hatchery Supported Class Constraints (for steelhead management separated into two subclasses; "augmented" and "hatchery"):

   (a) Emphasis on consumptive over nonconsumptive fishery for hatchery fish. Emphasis on numbers

over mean size in the catch or creel (i.e. a "quantity" versus "quality fishery").

(b) Restricted to highly accessible streams; i.e. for resident salmonids, restricted to "roadside" reaches.

(c) Manage with general regulations quota (2 to 4 daily, 4 to 8 possession) on moderate effort streams; no bait ban, size limit or seasonal closures.

(d) Reliant on stocking although regulations may specify different limits for marked hatchery fish.

(e) Emphasis is on stocking large yearlings (12-13 cm, 20-25 g; similar to Wyoming) or secondarily, large fall fingerlings (10-15 g similar to Wisconsin) to maintain resident trout fisheries.

(f) No restrictions on brood stock. A lake stock of trout or char could be used if research evaluations demonstrate negligible migration from the stream (e.g. Wyoming uses a lake stock of rainbow for stream stocking but no research has been conducted to compare their performance to a river stock; R. Wiley pers. comm.).

(g) "Catchables" stocking excluded aside from rare situations; urbanized water bodies or "slough type" stream where natural production is negligible and there is little conflict with sea-run trout (special "clean-up" fisheries for residualized sea-run trout could fulfill demand for "catchables" angling in coastal regions).

STRATEGIES FOR INVOKING SPECIAL REGULATIONS

Restrictive or special regulations are essential techniques for ensuring effective management of accessible resident salmonid stream fisheries. Both concepts of Wild Class A and Trophy Class streams are highly dependent on special regulations to ensure targets of acceptable 1) standing crops, 2) creel and catch success rates, and 3) fish size. The challenge for the fishery manager is to select regulations that are effective but do not unduly complicate the Regulations Synopsis and enforcement. This should be accomplished by limiting the number of potential options available which, in combination, are enumerable. The following special regulations

should remain fixed for resident salmonid fisheries on streams designated as Wild Class A and Trophy classes:

1. No bait except in winter (bait should be retained for traditional whitefish fisheries because incidental catch of trout and char is insignificant, Martin 1983). Hooking mortality from bait is 25% for barbed hooks versus 4-6% from artificial flies and lures (Wydoski 1977). This applies only to small trout (versus about 10% mortality on baited barbed hooks for adult steelhead; R. S. Hooton data on file, 1985).

2. Fixed spawning season closures.

3. Terminal tackle restricted to artificial lure and artificial fly (no fly only) to reduce hooking mortality of released fish to 5% (Wydoski 1977).

Flexible options for special regulations should be reserved for harvest quotas and size limits. However, it is recommended they are restricted mainly to reduced quotas and minimum size limits, designed to permit greater spawner escapement and an increase of larger fish in the catch.

1. Quotas: Flexibility is required as a result of varying productivity and effort levels. To significantly reduce harvest, a quota must be reduced to 3 or less (Hunt 1974). Four special quota options are required:

   (a) 0 - catch and release or closure
   (b) 1 per day
   (c) 2 per day
   (d) 3 per day

   In rare instances, quotas > 4/day could be required owing to "stunting", particularly in small productive streams with limited angling accessibility.

2. Minimum size limits: The main objective is to permit a greater percentage of the spawning population to escape harvest which will also result in a greater percentage of large or "quality" fish in the catch. Flexibility is required owing to variation in growth rates, which mainly result from variations in stream temperature and productivity. Four options are required (subject to further research evaluations):

   (a) 20 cm highly unproductive streams (cold oligotrophic)
   (b) 25 cm unproductive streams

(c) 30 cm productive streams
(d) 33 cm highly productive streams (moderate temperature regime, nutrient rich)

3. Maximum size limits: The main objective of maximum size limits is to distribute the catch and harvest of "trophy" sized fish among more anglers. An incidental benefit could be greater spawner escapement on low effort streams.

Stream specific regulations that set low maximum limits have been utilized to encourage the cropping of over-abundant size or age classes. This has been extended to what are termed "slot limits"; i.e. combined maximum and minimum size limits that protect most first time spawners while promoting a higher harvest of smaller fish and a limited harvest of trophy fish (e.g. Madison and Big Hole rivers, 3 < 33 cm and 1 > 56 cm, Wells 1983. S. Fork Snake River, 3 < 33 cm and 1 > 51 cm, Reid 1983, all highly productive streams). Temporary use of slot limits should not be ruled out as a means to re-attain a "quality fishery" if a minimum size limit begins to fail after several years of success (Reid 1983). An alternative is to return, temporarily, to the more liberal general regulation to crop smaller size classes, but this may not protect sufficient first time spawners.

SUMMARY

Stream fisheries, including resident salmonid fisheries, are in high demand and are important in British Columbia. Surveys of the status of resident trout and char stocks or fisheries suggest the demand greatly exceeds the supply.

1. Initial surveys of the stock status of several accessible streams supporting fisheries for trout and char indicated most populations are depressed or depleted. Serious shifts in management strategies are necessary for restoration and maintenance in order to be consistent with provincial policy goals of the Fisheries program.

2. Three options for more effectively managing resident trout and char stream fisheries include emphasis on a) rotating closures, b) stocking "catchables", and c) management classes incorporating special regulations. The option most compatible with provincial fisheries policy is emphasis on special regulations.

3. A management strategy involving four management classes or concepts is proposed. Wild A (accessible), Wild B (inaccessible), Trophy and Hatchery Supported designations are recommended for all stream fisheries in the province. Several constraints are attached to each class. Formal utilization of these classes will organize stream management so that it is more compatible with existing goals of provincial fisheries management policy in British Columbia.

4. Special regulations are necessary for two of the four management classes to ensure targets of acceptable a) standing crop, b) catch rate, and c) fish size. However, owing to the enumerable combinations of special regulations, several constraints are recommended to minimize complexity in the Sport Fishing Regulations Synopsis.

5. Various effects of special regulations are summarized from the current literature and fisheries conferences (Appendix 1). Evidence for their usefulness is becoming substantial although further research evaluations are required for streams with low productivity and extreme winter conditions. Adequate public education is necessary for realizing full benefits, particularly increases in "trophy" trout that can result from compliance with special regulations.

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Appendix 1

SUMMARY OF THE EFFECTS OF SPECIAL REGULATIONS

1. Invoking special regulations with catch and release only (no kill) initially decreases effort on average by about 40% (Lewynsky 1982 M.S.), unless the trout population was depressed, whereby effort increases (Nehring 1983). On resident trout streams, effort generally returns to about the 80% level after two years.

2. Under a catch and release only regulation, catch and trout numbers in streams can increase on average by approx. 4 and 10-fold, respectively, within five years if the population was depleted (Nehring 1983). Catch rates of large trout can increase substantially (e.g. 3 times for rainbow trout and 28 times for trout > 38 cm; Anderson and Nehring 1984).

3. Total hooking or handling mortality is low under a bait ban. For example, at the Madison River the mortality rate of trout from repeated handling during catch and release angling was estimated to be 20 to 30% at a high level of effort 840 days/km (Wells 1983). There is considerable "recycling" of fish in highly used catch and release fisheries. For example, it has been estimated that trout are recycled seven to ten times over at Yellowstone River with 20-30% post-handling mortality using artificial lure and fly restrictions (Gresswell 1983, pers. comm. 1984).

4. Limited kill regulations (versus catch and release) probably have little long term effect on effort (Slaney et al. 1984 M.S.), unless the trout population was depressed or depleted, whereby effort increases substantially (Nehring 1983).

5. Under well designed, special regulations, total catch (killed plus released) typically increases 100% over a typical consumptive fishery that was sustainable under relatively liberal regulations (Slaney et al. 1984 M.S.).

6. Where populations are sustained under general regulations, numbers of age 1+ and older trout can increase about 50% under special regulations (Lewynsky 1982 M.S.). Rainbow trout, cutthroat trout and grayling respond better than brown trout owing to lower catchability of the latter. Larger size classes of trout increase significantly (> 41 cm, 21%, Moore et al. 1979 M.S.; > 33 cm, 12%, Hunt 1981), unless noncompliance is common whereby there is no increase (Lewynsky and Bjornn 1982 M.S.).

7. There is limited evidence that in streams with extreme winter conditions (e.g. anchor ice) or low productivity that special regulations are less effective, at least for increasing trophy fish (Gallatin River, Wells 1983). Rather, natural mortality replaces fishing mortality, but further research evaluations are required.

8. To obtain desired results from special regulations, adequate public education is required to obtain compliance without a marked increase in enforcement (Nehring 1983). For example, to improve compliance "spot" television advertisements are used effectively in Colorado for their catch and release regulations (Nehring 1983).

Appendix 1. Effort, catch, yield, and standing crop statistics for resident salmonid streams in North America, by area (hectares) (excluding whitefish) (standing crop = age 1+ and older, mainly fall estimates).

Stream	m Width	Loc.	Days/ha Effort	kg/ha Catch	kg/ha Yield	kg/ha St. Crop	cm Size Reg.	TDS	Stocked	Species	Source
S. F. Boise[2]	∿ 25	Id	189	183	11	-	30	-	Nil	Rbt	Moore *et al.* 1979
C. L. Poudre[2]	20	Col	34	43	6	72 (Spring)	30	44	Nil	*Rbt*, Brn	Klein 1974
C. L. Poudre[3]	20	Col	29	35	26	53	15?	44	Catchables excluded	" "	" "
Oldman[1]	11	Alta.	182	∿ 47	45	-	Nil	262	Nil	*Cut*, DV	Radford 1977
Willow	13	Wisc.	672	∿ 100	79	69	15	258	@ 15 g	*Brn*, Rbt	Hunt 1981
Race	12	"	878	∿ 120	90	96	15	274	@ 15 g	" "	" "
Race[2]	12	"	836	∿ 230	5	145	33	274	@ 15 g	" "	" "
Green	99	Wy	59		7.3	55	15?	300	@ 10 g	*Rbt*, Brn	Wiley & Dufek 1980
Dutch[1]	8	Alta.	339	∿ 45	43		Nil	233	Nil	*Cut*, DV	Radford 1977
L. Plover	4	Wisc.	559		50	93	15	234	Nil	Brk	Hunt 1979
Lunch	4	"				152	15			Brn	Hunt 1979
Spring	3	"				176	15			Brk	Hunt 1979
Wedde	4	"	422		77	183	15	193	Nil	*Brn*, Brk	Avery & Hunt 1981
Radley	5	"	327		44	149	15	204	Nil	" "	"
Mecan	7	"	383		41	83	15	223	Nil	" "	"
Emmons	6	"	340		39	169	15	220	Nil	" "	"

[1] Rotational openings (annual).

[2] Special regulations.

[3] Section (1) 16 kg/ha yield, 44 kg/ha spring standing crop; Section (2) 35 kg/ha yield, 62 kg/ha S.C. (Note: spring standing crops are slightly less than fall standing crops because growth compensates for moderate fishing mortality.)

Appendix 2. Effort, catch, yield and standing crop statistics for resident salmonid streams in North America, by length (km) (excluding whitefish) (standing crop = age 1+ and older, mainly fall estimates).

Stream	m Width	Loc.	Days/km Effort	kg/km Catch	kg/km Yield	kg/km St. Crop	cm Size Reg.	TDS	Stocked	Species	Source
S. F. Boise[2]	~ 25	Id	473	459	27	-	30	-	Nil	Rbt	Moore *et al.* 1979
C. L. Poudre[2]	20	Col	67	73	11	132	30	44	Nil	*Rbt*, Brn	Klein 1974
C. L. Poudre	20	Col	56	69	51	106	15?	44	Catchables excluded	" "	" "
Oldman[1]	11	Alta	200	~ 88	86	-	Nil	262	Nil	*Cut*, DV	Radford 1977
Willow	13	Wisc	898		106	91	15	258	@ 15 g	*Brn*, Rbt	Hunt 1981
Race	12	"	1054		108	115	15	274	@ 15 g	" "	" "
Race	12	"	1004		6	175	33	274	@ 15 g	" "	" "
Green	99	Wy	596		73	552	15?	300	@ 10 g	*Rbt*, Brn	Wiley & Dufek 1980
Dutch[1]	8	Alta	271	~ 37	35		Nil	233	Nil	*Cut*, DV	Radford 1977
L. Plover	4	Wisc	217		19	36	15	234	Nil	Brk	Hunt 1979
Lunch	4	"				56	15		-	Brn	Hunt 1979
Spring	3	"				53	15		-	Brk	Hunt 1979
Wedde	4	"	156		29	70	15	193	Nil	Brn, Brk	Avery & Hunt 1981
Radley	5	"	172		23	76	15	204	Nil	" "	"
Mecan	7	"	180		28	55	15	223	Nil	" "	"
Emmons	6	"	197		23	98	15	220	Nil	" "	"
Lochsa		Id	230 }								Lindland & Pettit 1981 MS
Henrys F.		"	339 }	medium to							Rohner 1981 MS
Teton		"	162 }	large streams							Jeppson 1982 MS
S. F. Snake		"	293 }								Moore 1980
Elk[3] (100 km)		BC	232								Martin 1983

[1] Rotational openings (annual)
[2] Special regulations
[3] Plus 209 days/km on whitefish

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